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August 17, 2000

Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of
Richard D. Simon and Richard H. Wilson for a GRAVITY FLOW SLUDGE
LOAD-OUT SYSTEM.

Enclosed are the following:

Specification and Claims (13 pages);

Drawings (2 sheets, informal);

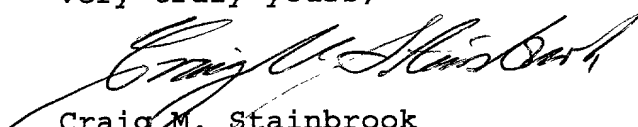
Declaration and Power of Attorney;

Verified Statement Claiming Small Entity Status
(Independent Inventor); and

Verified Statement Claiming Small Entity Status
(Small Business Concern);

Check for the filing fee of \$345.00.

Very truly yours,


Craig M. Stainbrook
Registration #45,126
Attorney for Applicant

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09642249-081700

Applicant or Patentee: Richard D. Simon & Richard H. Wilson
Serial No.: _____ Filing Date: _____
Patent No.: _____ Issued: _____
For: GRAVITY FLOW SLUDGE LOAD-OUT SYSTEM

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY
STATUS (37 CFR 1.9(f) AND 1.27(b)) -- INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled

GRAVITY FLOW SLUDGE LOAD-OUT SYSTEM

described in

- ☒ the application filed herewith
☐ application serial no. _____, filed _____
☐ patent no. _____, issued _____

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey or license any rights in the invention is listed below:

- ☐ no such person, concern or organization
☒ persons, concerns or organizations listed below*

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27).

FULL NAME: Material Systems Engineers
ADDRESS: 185 N. Redwood Dr., Suite 130
San Rafael, California 94903

☐ INDIVIDUAL ☒ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement directed.

NAME OF INVENTOR: Richard D. Simon

Date: 8/15/2000

Richard D. Simon
Signature of Inventor

NAME OF INVENTOR: Richard H. Wilson

Date: August 15, 2000

R H. Wilson
Signature of Inventor

Applicant or Patentee: Richard D. Simon & Richard H. Wilson
Serial No.: _____ Filing Date: _____
Patent No.: _____ Issued: _____
For: GRAVITY FLOW SLUDGE LOAD-OUT SYSTEM

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VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY
STATUS (37 CFR 1.9(F) and 1.27(c))--SMALL BUSINESS CONCERN

I hereby declare that I am
☐ the owner of the small business concern identified below:
☒ an official of the small business concern empowered to act
on behalf of the concern identified below:

NAME OF CONCERN: Material Systems Engineers
ADDRESS OF CONCERN: 185 N. Redwood Dr., Suite 130
San Rafael, California 94903

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled GRAVITY FLOW SLUDGE LOAD-OUT SYSTEM by inventor(s) Richard D. Simon and Richard H. Wilson described in:

☒ the application filed herewith
☐ application serial no. _____, filed _____.
☐ patent no. _____, issued _____.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27).

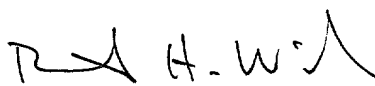
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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

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SIGNATURE  DATE August 15, 2000

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

*Utility Patent Application
for
United States Letters Patent*

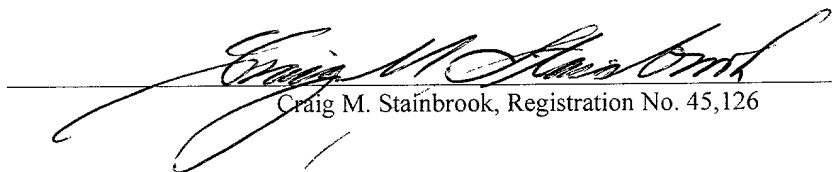
Gravity Flow Sludge Load-Out System

CERTIFICATE OF MAILING BY U.S.P.S. EXPRESS MAIL

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8/17/00
Date of Deposit

The undersigned hereby certifies that this Patent Application is being deposited with the United States Postal Service "Express Mail Post Office to Addressee Service" in accordance with the provisions of 37 CFR Section 1.10 on the date indicated above and is addressed to The Assistant Commissioner for Patents, Box PATENT APPLICATION, Washington, D.C. 20231


Craig M. Stainbrook, Registration No. 45,126

Inventors: Richard D. Simon and Richard H. Wilson

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Gravity Flow Sludge Load-Out System

BACKGROUND OF THE INVENTION

5 Cross Reference to Related Applications

Not applicable.

Field of the Invention

10 The present invention relates generally to systems for loading out large volumes of dewatered biosolids for transport, reuse, and disposal, and more particularly to a gravity flow sludge load-out system for rapid and highly controlled automated loading out of biosolids into container trucks.

Discussion of Related Art

15 The treatment and disposal of large volumes of sewage sludge has been a problem for many years. Numerous methods have been devised to render biological sludge generally pathogen free and suitable for reuse as soil amendment and fertilizer; and numerous other methods have been devised to make unusable sludge easier to transport for disposal. However, regardless of its ultimate destiny, treated sludge is typically stored briefly at a sewage treatment facility and then loaded out into containers for transport either to sludge customers or to disposal sites. And in
20 facilities with high wastewater throughput, the sludge must be loaded out quickly and efficiently to avoid the accumulation of a large sludge inventory.

Furthermore, in the case of large municipalities, it is not uncommon for fertilizer plant

sludge customers to demand a supply of several hundred thousand pounds of sludge each day.

The logistics and mechanics of providing such an ongoing supply demands, firstly, that the system loads sludge quickly, not only to meet the demand for supply, but also to minimize time wasted by trucking and other transportation concerns; and, secondly, the system must load out the sludge with a high degree of accuracy, because municipalities must accurately track charges for the supply and must further maintain certified records pertaining to the disposition of specific amounts of hazardous waste. For billing purposes alone, the tolerances must typically be within $\pm 1\%$. However, providing this degree of accuracy while simultaneously providing high throughput has not been achieved by prior art known to the present time. The source of the problem lies in large fluctuations in sludge flow rates, due, in turn, to large fluctuations in sludge viscosity caused by batch variants in sludge dehydration and temperature, and varying material heights or head pressures in the loading hoppers.

Another challenge in designing a sludge load-out system that provides rapid and accurate loading out is to provide a system capable of measuring real-time load-out status. Such a system feature is not merely desirable but mandatory at facilities where truck scales will not or can not be provided to measure loading status. Moreover, it is desirable to provide a variable load-out orifice to permit fine control of the sludge flow so as to minimize splattering and sludge loss; however, with such an orifice, flow meters cannot provide an accurate measurement of real-time flow. Finally, a system including real time sludge flow monitoring has not been devised in those systems in which hoppers are refilled while dispensing their content.

Accordingly, it is an object of the present invention to provide an automatic sludge load-out system that loads-out large volumes of sludge quickly and accurately.

It is a further object of the present invention to provide a sludge load-out system that measures real-time load-out status while also providing simultaneous load-out and hopper refilling.

It is yet another object of the present invention to provide a sludge load-out system that includes hoppers having variable load-out gate orifices.

SUMMARY OF THE INVENTION

The gravity flow sludge load-out system of the present invention provides a means for rapidly and accurately loading-out large volumes of treated biosolids from a wastewater dewatering plant. The system comprises at least one hopper, each supported by a main structure having a plurality of vertical support members. Each hopper rests on dedicated load cells. Each hopper has at least one inlet at the top for the introduction of sludge from the dewatering facility. Each hopper further includes a powered metering gate at the bottom, each including power means on each side, support rollers to support the gate blade, position sensors to establish the position of the blade during the load-out process, and proximity/limit switches to confirm fully opened and closed gate positions . The power means are preferably hydraulic, pneumatic, or electric cylinders having pistons connected to the metering gate blade.

Immediately above the hoppers is a sludge distribution container having a motorized distribution screw and outlets above each hopper. Interposed between the sludge distribution container outlets and the hopper are hydraulically controlled slide gates. Dewatered solids are conveyed from the dewatering facility centrifuges to the sludge distribution container via a conveyor system or pumped via pipes.

and 26. Each hopper rests on a dedicated load cell, 28, 30, 32, and 34. Alternatively, the support members may be support on load cells, though it is preferable for the hoppers alone to rest on the cells.

Each hopper has at least one inlet at the top, 36 and 38, respectively, for the introduction of sludge from the dewatering facility. Each hopper further includes a hydraulically controlled metering gate at the bottom, 40 and 42, respectively. A metering gate suitable for use in the system shown in Fig. 1, both as a slide gate and as a metering gate, is described in detail in U.S. Pat. Application, filed concurrently with the instant application, and entitled, Gravity Flow Sludge Metering Gate, incorporated herein by reference. As set out in that application, the metering gates are powered, preferably by at least one hydraulic, pneumatic, or electric, cylinder on at least one side. Rollers are used to support the gate blade and position sensors are used to establish the position of the blade during the load-out process.

Immediately above the hoppers is a sludge distribution container 44 having a motorized distribution screw 46, a first outlet 48 above the first hopper, and a second outlet 50 above the second hopper. Interposed between the first outlet and the first hopper is a first powered slide gate, or conveyor shut-off gate 52, and between the second outlet and second hopper a second powered conveyor shut-off gate 54. Dewatered solids are conveyed from the dewatering facility centrifuges 56 to the sludge distribution container via a conveyor system 58.

When a hydraulic system, for example, is employed, movement of the mechanical components of the gate system, i.e., the shut off gates and the metering gates, is powered by a hydraulic power unit comprising a pump 60, fluid reservoir 62, and an accumulator bank having at least one accumulator 64. The power unit is operatively connected to the shut-off and metering

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gates by a series of hydraulic lines 66. When a gate is opened or closed, the accumulator provides hydraulic pressure to the hydraulic cylinders to actuate gate blade movement. When the stored energy drops below a specified pressure, the pump automatically charges the accumulators. As dictated by load-out needs, the gates may be opened completely, closed completely, or held in an
5 intermediate position, as is well known in the art. A functionally comparable pneumatic or electric power system may be substituted for the above-described hydraulic system without affecting the overall system characteristics.

To monitor load-out status and control load-out function, the system further includes a control panel comprising a programmable logic controller (PLC) 70, connected via data
10 communication signal lines 72 with a personal computer 74, operator interface stations 76 and 78, at least one dewatering facility magnetic flow meter 80, and each load cell. The PLC is also connected to valve panels 82, 84, 86, and 88, for each shut-off gate and each metering gate to selectively position or stabilize the gate blade, and further to sludge level sensors 90 and 92, which convey data to the PLC regarding the static or dynamic height of sludge in the hopper.

15 Preliminary to load-out, treated sewage is partially dewatered by a treatment plant's centrifuge system 56. The sludge may be passed through an optional magnetic flow meter 80, which provides sludge flow amounts to the PLC, and then onto a conveyor 58a. Alternatively, the sludge may be loaded directly into the distribution container 44 via sludge transfer pipe 58b. The solids are then distributed within the distribution container to the hoppers and the hoppers are
20 filled in preparation for load out.

In automatic mode the load-out operator uses a touchpad or key pad at the operator interface station to input truck 90 and customer identification information and intended load

weights. The touchpad transmits this data to the PLC where it is integrated to effect metering gate operation. On initiation of the load-out cycle from the PLC, the metering gate moves to its full open ("course") position and initiates sludge flow. When approximately 70% of the desired load is reached (in most instances approximately 35,000 lb in approximately two minutes), the PLC
5 moves the gate to an intermediate position until 95% of load-out is reached. The gate then closes to the "fine" position until 100% of the load-out weight (approximately 50,000 lb) has been completed. The PLC then closes the gate completely, terminating load-out.

The PLC determines gate positioning as a function of the current weight of sludge loaded to the truck. This real-time loaded-out weight is calculated from hopper weight measurements and
10 sludge flow into hoppers. These two measurements are scanned by the PLC every second to maintain an accurate accounting of sludge loaded into the truck.

When the operator initiates the load-out sequence, the PLC takes a snapshot of the hopper weight at the beginning of the sequence (i.e., hopper tare weight). The current total hopper weight is continuously monitored as sludge is loaded into the trucks. The net weight loaded into
15 any truck at any given time is the initial hopper (tare) weight minus the current hopper weight, plus the total sludge flow into the hopper from the centrifuges calculated from the beginning of the load-out sequence. The optional magnetic flow meter at the centrifuge provides sludge-flow amounts to the PLC, though this information is additive and is not required for highly accurate load-out.

20 Tare and current hopper weights are measured by load cells **28** through **34**. The gross weight measurement of the hoppers is accurate to 0.1% of span (0-75,000 lb). The weight measurement system subtracts the hopper tare weight from the actual hopper weight to determine

the net sludge weight in the hopper at any time.

The loaded-out net weight is then used by the PLC for execution of its three primary control functions: (1) automatic sludge load-out from the loading hoppers; (2) automatic refilling of the hoppers; and (3) transmission of transaction data for accounting purposes.

5 The PLC tracks and controls hopper refilling by using hopper net weight status to modulate sludge transfer from the centrifugal dehydrators to the loading hoppers via the slide gates. The hoppers are filled to a predetermined differential weight as compared to one another. The hopper with the lowest weight is refilled first. When that hopper's net sludge weight exceeds the differential, as compared to the previous highest hopper weight, the filling sequence is
10 redirected to the new lowest weight hopper and the cycle continues until all hoppers are filled. In this fashion, a multi-station, multi-hopper system can be tightly controlled so that several container trucks be serviced simultaneously, and each truck may be loaded evenly. For example, a container truck having a generally elongate container may be positioned under two or three
15 hoppers. If a single 50,000 lb mound of sludge were piled high into only one part of the truck bed, vehicle balance and handling would be adversely effected and sludge could be blown free at highway speeds. Accordingly, loading platforms may be optimally designed with multiple hoppers at each truck loading station to ensure even load-out for each vehicle. The distribution of sludge through each station hopper, regardless of the number, is controlled under precisely the same principle set out above.

20 In some instances, manual control of load-out may be desirable. The present system contemplates and accommodates such an alternative by providing a position switch **100** wired to the PLC which allows the operator to override the automatic system. The operator can then

control the gate position and can terminate the load-out sequence at any time. Under either automatic or manual control, the operator interface panels **76** and **78** provide the operator with information regarding net hopper weights, load out status, and customer information.

When the load-out is completed, the system prints a bill of lading on printer **102**. The bill of lading includes truck identification information and load-out weight. The driver checks the accuracy of the information before leaving the load-out station. It may be confirmed by district personnel at an independent truck scale before the truck leaves the plant. In this fashion, accurate records of the transportation and handling of hazardous waste.

Fig. 2 is a side elevation view of a three-bay load-out station **110** in operation. This view shows a sludge transport truck **T** positioned underneath all three load-out hoppers, **112**, **114**, and **116**, of the station. Immediately above the truck's container **C** are three load-out metering gates, **118**, **120**, and **122**, in the open position and, in accordance with their design, directing sludge flow **F** throughout the length of the container for even distribution of load-out. Shut-off gates **124** control fill from the distribution container **126**, which is filled from sludge conveyor **128**. Finally, Fig. 2 shows that each load-out metering gate has flow control means comprising an actuator **130** operatively connected to respective metering gate blades **132** via an extendable/retractable piston or operating stem **134**.

While this invention has been described in connection with preferred embodiments thereof, it is obvious that modifications and changes therein may be made by those skilled in the art to which it pertains without departing from the spirit and scope of the invention. Accordingly, the scope of this invention is to be limited only by the appended claims.

CLAIMS

What is claimed as invention is:

What is claimed as invention is:

5 1. A gravity flow sludge load-out system for controlling the flow rate at which sludge
is out-loaded, said system comprising:

at least one hopper having an outlet at its lower end, said at least one hopper for storing
and delivering a volume of sludge load-out;

10 at least one sludge gate co-located at the outlet of said lower end of said at least one
hopper, said sludge gate having a fully opened and a fully closed position and variable positions
therebetween;

flow control means for automatically adjusting the position of said at least one sludge gate
for controlling the flow of sludge load-out through said sludge gate; and

a support framework on which said hopper and said sludge gate are mounted.

15 2. The gravity flow sludge load-out system of claim 1 wherein said flow control
means comprises:

an actuator for mechanically moving said sludge gate to and from its variable positions;

an operator interface terminal (OIT) for user input and display of sludge load-out data.

20 3. The gravity flow sludge load-out system of claim 2 wherein said sludge load-out
data includes sludge batch weight and height level of sludge in said hopper.

4. The gravity flow sludge load-out system of claim 3, wherein said sludge load-out
date further includes sludge flow rate.

5. The gravity flow sludge load-out system of claim 2 further comprising a programmable logic controller (PLC) operatively connected to said OIT and said actuator.

6. The gravity flow sludge load-out system of claim 5, wherein said flow control means further includes a weigh system for measuring the load-out weight, said weigh system comprising load cells mounted on said support framework below said at least one hopper and electrically connected to said PLC to transmit signals to said PLC.

7. The gravity flow sludge load-out system of claim 5 wherein said PLC continuously monitors the weight of load-out content in said at least one hopper, continually compares the load-out batch weight to the amount of sludge loaded out through said at least one sludge gate, and selectively adjusts the position of said sludge gate(s) to control the flow rate.

9. The gravity flow sludge load-out system of claim 5 wherein said flow control means includes sludge height level sensors electrically connected to said PLC to transmit sludge level data to said PLC

10. The gravity flow sludge load-out system of claim 5 wherein said PLC continuously monitors the sludge weight remaining in said hopper during a load-out operation and systematically decreases the sludge flow rate as the weight of sludge in said hopper approaches a preselected batch load out weight.

11. The gravity flow sludge load-out system of claim 5 wherein said PLC continuously calculates the loss in weight per unit time of sludge from said hopper and adjusts the position of said sludge gate to maintain a constant flow rate.

12. The gravity flow sludge load-out system of claim 5 wherein said flow control means includes at least one position sensor located within each of said at least one sludge gate,

said position sensor(s) electrically connected to said PLC to transmit signals to said PLC.

13. The gravity flow sludge load-out system of claim 1 wherein said at least one sludge gate is pneumatically powered.

14. The gravity flow sludge load-out system of claim 1 wherein said at least one
5 sludge gate is hydraulically powered.

15. The gravity flow sludge load-out system of claim 1 wherein said at least one sludge gate is electrically powered.

Gravity Flow Sludge Load-Out System

ABSTRACT OF THE DISCLOSURE

A gravity flow sludge load-out system for rapid and accurate loading-out of large volumes of treated biosolids from a wastewater dewatering plant, said system comprising at least one hopper supported by a main structure having a plurality of vertical support members, each resting on a load cell, a sludge inlet at the top of each hopper, and hydraulically controlled metering gates at the bottom. A PLC controls delivery of sludge from a dewatering facility into the hopper and then controls load-out of the sludge to a container truck by providing real-time monitoring of net sludge load-out and tight control of metering gates.

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled GRAVITY FLOW SLUDGE LOAD-OUT SYSTEM, the specification of which [X] is attached hereto or [] was filed on _____ as Application Serial No. _____ and was amended on _____ (if applicable).

I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, section 1.56(a). I claim foreign priority benefits under Title 35, United States Code, section 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):

<u>COUNTRY</u>	<u>APPLICATION NUMBER</u>	<u>DATE OF FILING</u>	<u>PRIORITY CLAIMED UNDER 35 U.S.C. 119</u>
<u>n.a.</u>			

I claim the benefit under Title 35, United States Code, section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

<u>APPL. SERIAL NO.</u>	<u>DATE OF FILING</u>	<u>STATUS</u>
<u>n.a.</u>		[] Patented [] Pending [] Abandoned

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney to prosecute this application and transact all business in the Patent and Trademark Office therewith:

address: Larry D. Johnson (Registration Number 31,528)
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0964249-081700

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I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: 8/15/2000

Richard D. Simon
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Date: August 15, 2000

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